Shortraker rockfish − *Sebastes borealis*

Overall Vulnerability Rank = Moderate

Biological Sensitivity = High

Climate Exposure = Moderate

Sensitivity Data Quality = 58% of scores ≥ 2

Exposure Data Quality = 56% of scores ≥ 2

	Sebastes borealis	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Habitat Specificity	1.9	2.1	
	Prey Specificity	1.8	2.4	
	Adult Mobility	2.4	2.0	
	Dispersal of Early Life Stages	1.6	1.5	
	Early Life History Survival and Settlement Requirements	2.5	1.4	
	Complexity in Reproductive Strategy	2.3	1.4	
	Spawning Cycle	3.6	1.8	
	Sensitivity to Temperature	3.2	2.4	
	Sensitivity to Ocean Acidification	2.1	2.4	
	Population Growth Rate	3.9	2.0	
	Stock Size/Status	1.4	1.5	
	Other Stressors	1.1	2.0	
	Sensitivity Score	High		
Exposure factors	Sea Surface Temperature	2.0	2.0	
	Sea Surface Temperature (variance)	1.9	2.0	
	Bottom Temperature	2.2	2.0	
	Bottom Temperature (variance)	2.9	2.0	
	Salinity	1.2	2.0	
	Salinity (variance)	2.7	2.0	
	Ocean Acidification	4.0	2.0	
	Ocean Acidification (variance)	1.3	2.0	
	Phytoplankton Biomass	1.1	1.2	
	Phytoplankton Biomass (variance)	1.2	1.2	
	Plankton Bloom Timing	1.7	1.0	
	Plankton Bloom Timing (variance)	2.2	1.0	
	Large Zooplankton Biomass	1.1	1.0	
	Large Zooplanton Biomass (variance)	1.5	1.0	
	Mixed Layer Depth	1.9	1.0	
	Mixed Layer Depth (variance)	2.3	1.0	
	Currents	1.4	2.0	
	Currents (variance)	1.7	2.0	
	Air Temperature	NA	NA	
	Air Temperature (variance)	NA	NA	
	Precipitation	NA	NA	
	Precipitation (variance)	NA	NA	
	Sea Surface Height	NA	NA	
	Sea Surface Height (variance)	NA	NA	
	Exposure Score	Moderate		
	Overall Vulnerability Rank	Moderate		

Low
Moderate
High
Very High

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Shortraker Rockfish (*Sebastes borealis*)

Overall Climate Vulnerability Rank: **Moderate**. (74% certainty from bootstrap analysis).

Climate Exposure: **Moderate**. Exposure to ocean acidification (4.0) was ranked as "very high", and exposure to variability in bottom temperature (2.9) and variability in salinity (2.7) were ranked as "moderate".

Biological Sensitivity: **High**. Population growth rate (3.9) and spawning cycle (3.6) were ranked as "very high" sensitivity, and sensitivity to temperature was ranked as "high".

Potential for distribution change: **High** (99% certainty from bootstrap analysis). Three attributes (dispersal of early life stages, habitat specificity, and sensitivity to temperature) indicated high potential for distribution change.

Directional Effect in the Eastern Bering Sea: Projected climate change in the eastern Bering Sea is expected to have a negative effect on Shortraker Rockfish, with 60% certainty in expert scores.

Data Quality: 58% of the sensitivity attributes, and 56% of the exposure factors, had average data quality scores of 2 or greater (indicating at least "moderate" data quality).

Climate Effects on Abundance and Distribution:

Small and juvenile shortraker rockfish are dependent upon copepods and euphausiids, which have calcareous exosketetons. The degree to which ocean acidifcation may affect the reproduction and survival of these prey species, and the degree to which shortraker rockfish could switch to other prey species if copepods and euphausiids decline in abundance, are unknown. The survival of larvae is thought to be more strongly dependent upon the availability of suitable prey than on predation pressure.

Life History Synopsis:

Shortraker rockfish are found along the eastern Bering Sea slope, ranging from 54° N to north of 60° N (the northern limit of the EBS slope survey). Shortraker rockfish are a mostly demersal species, but may also be found off-bottom. As adults, shortraker rockfish occur primarily at depths from 300 m to 500 m. Kreiger (1992) used a submersible to find that shortraker rockfish occurred over a wide range of habitats, with the highest density of fish on sand or sand or mud substrates. Additional submersible work in southeast Alaska indicates that rougheye rockfish and shortraker rockfish were associated with habitats containing frequent boulders, steep slopes (more than 20E), fine-grained substrates of silt, pebbles, or cobble (Krieger 1992), and sand-mud substrates (Kreiger and Ito 1999). Krieger and Wing (2002) found that large rockfish had a strong association with Primnoa spp. coral growing on boulders, and it is likely than many of these large rockfish were shortraker rockfish. Commercial fishermen have reported that shortraker rockfish school above rugged, steep-slope habitat (Krieger 1992).

Shortraker Rockfish have a complex reproduction strategy involving courtship, mating, and internal fertilization and embryonic development, similar to other rockfish species (Love 2002). Fecundity is a function of the food available, which itself is an indirect function of temperature

via oceanographic conditions, and temperature-dependent metabolic rates. These factors also affect the rate of embryonic development and the date of parturition. The timing of reproductive events is protracted; parturition (the release of larvae) may occur from February through August (McDermott 1994), although Westrheim (1975) found that April was the peak month for parturition. Within this range (February through August), ocean conditions vary in the Bering Sea; therefore, variability in food availability and parturition may account for some variability in early survival and recruitment success (Love 2002). Information from other rockfish species suggests that juveniles settle to benthic environments within 3- 6 months of parturition.

Limited information available suggests that the diet of shortraker rockfish consists largely squid, shrimp, and myctophids (Yang 2003). Collections in 1994 and 1997 from the Aleutian Islands indicated that the diet of large shortraker rockfish had proportionally more fish (e.g. myctophids) than small shortraker rockfish, whereas smaller shortrakers consumed proportionally more shrimp (Yang 2003).

Shortraker rockfish are managed in the eastern Bering Sea and Aleutian Islands as a single stock (Spies et al. 2016). Analyses of spatial genetic structure suggest that distinct populations exist on the scale of the ocean basin (i.e. Bering Sea vs. Gulf of Alaska). Population structure for Shortraker rockfish has been observed in microsatellite data (Matala et al. 2004), with the geographic scale consistent with current management regions (i.e., GOA, AI, and EBS). The most efficient partitioning of the genetic variation into non-overlapping sets of populations identified three groups: a southeast Alaska group, a group extending from southeast Alaska to Kodiak Island, and a group extending from Kodiak Island to the central AI (the western limit of the samples). Thus, genetic data do not suggest fine scale structuring of spawning sites, although a higher resolution genetic technique may reveal finer scale structuring, similar to Pacific ocean perch (Palof et al. 2011). Shortraker rockfish are long-lived, with the maximum age 116 years. They reach 50% maturity at 21.4 years and have a relatively low rate of instantaneous natural mortality at 0.03 $year^{-1}$.

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